

Coats of Himalayan Ruminants Elucidated by Study of a “Yeti” Skin

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Gross and microscopic observations of the coat of a supposed “yeti” akin from Tibet led to its identification as tahr (*Hemitragus jemlahicus*), a species intermediate between sheep and goats. Details of coat structure and hair measurements are recorded and compared with those of other little-known Himalayan Ruminants: wild and domestic yak (*Bos mutus* and *grunniens*), serow (*Capricornis sumatrensis*), goral (*Nemorhaedus goral*) and ibex (*Capra ibex*).

Introduction

A supposed yeti skin brought back from Nepal by the mountaineer Alan Hinkes in the spring of 1990 was made available for study by Iain Walker of the *Mail on Sunday*. It was said to be from an animal preserved in a glacier in Tibet. Shackley (1983) indicated that sightings of yeti in this region are ape-like, so the hair of primates was compared. Eventual identification as tahr (*Hemitragus jemlahicus*) was of particular interest as it extended my study of the goat-antelopes of the Himalayas as sources of the textile fibre “shah-tus”, and of the ibex as a possible ancestor of the domestic cashmere goat, the underwool of which forms cashmere fibre (Ryder, 1987). The findings add to our meagre knowledge of these species (Schaller, 1977).

Methods

Since animal hair in general lacks striking features enabling the species to be readily identified, a process of elimination was followed. A small tuft of the “yeti” coat was taken and a short length was cut from the base of this sample to make a whole mount preparation. A projection microscope was used to measure the diameter of 100 fibres from the coat. These measurements are made in microns and expressed as a histogram, which shows the distribution of hair diameter and in turn defines coat structure and type. Hair measurements for comparison were made of one sample from wild yak (*Bos mutus*) and five from domestic yak (*Bos grunniens*), two samples of ibex (*Capra ibex*) coat and three of tahr (*Hemitragus jemlahicus*) plus one each of serow (*Capricornis sumatrensis*) and goral (*Nemorhaedus goral*). When I asked to see the “yeti” material that McNeely *et al.* (1973) had seen at the Natural History Museum, London, the only item located was an imitation scalp made from cattle skin.

Observations

Gross features

The skin was a strip from over the shoulders, the parting of the hair along the backbone being evident (Plate 1). It measured 38cm anterior-posteriorly and 46cm from side to side, but with a taper to about 30cm wide at the anterior side of the strip. No inguinal region was evident. The skin was 2mm thick, which is greater than in



Plate 1. The "yeti" skin held by the Nepalese couple who passed it to Alan Hinkes. (Photo Alan Hinkes)

sheep or goats, but not as thick as in yak.

The hair was particularly long and straight, and was mostly dark brown in colour. There was no paler (agouti) band near the tip of the hairs (associated with a white-belly). The hairs had a paler base (caused by a reduction in pigment formation at the end of the hair growth cycle in winter, Ryder, 1973). This indicates death in winter and that the coat length is the maximum. The hairs were 20cm long and formed an outer coat, obscuring a very fine, white underwool only 2cm in length. Such coat structure, with underwool lacking pigment, is not found in bears and primates, but is typical of many species of the Ruminant (*Pecora*) Sub-order.

Towards the anterior side of the strip the coat had a mixture of white hairs. This part of the coat sloped away from the edge of the skin, but where the coat colour changed to brown one quarter of the way across the strip, the hair slope changed direction, so that the hair tips of the two colours pointed towards one another and in places overlapped. The white part apparently formed a ruff, and the same change in hair slope was later seen in tahr skins.

Microscopic details

Microscopic examination confirmed the big difference in thickness between the outer hairs (forming 20% of the coat) and the underwool (Table 1). Burns (1962) did

not mention the underwool of the Khumjung “yeti” scalp, but estimated the coarsest hairs to be 100-200 microns in diameter, a common thickness in goats, but greater than any in the present study.

The medulla (usual in coarse hairs) had a latticed structure, which again is not found in bears or primates, but is typical of wild sheep and goats. (The hairs of the Khumjung scalp, likened to the serow by Burns (1962), had non-latticed medullae). These observations also exclude fur-bearing mammals, which have less difference in size between the outer hair and underwool, and also commonly have a “ladder” medulla. The lattices of the medulla in this “yeti” hair were of a size and shape I have previously associated with goats rather than with sheep. On the other hand, the margins of the scales of the cuticle of the underwool had a “near” distance apart and so were comparable with sheep and different from the “distant” margins of goat underwool and the “close” margins of human hair. I had previously noted that tahr underwool had a cuticular

Table 1. Hair diameter measurements in microns

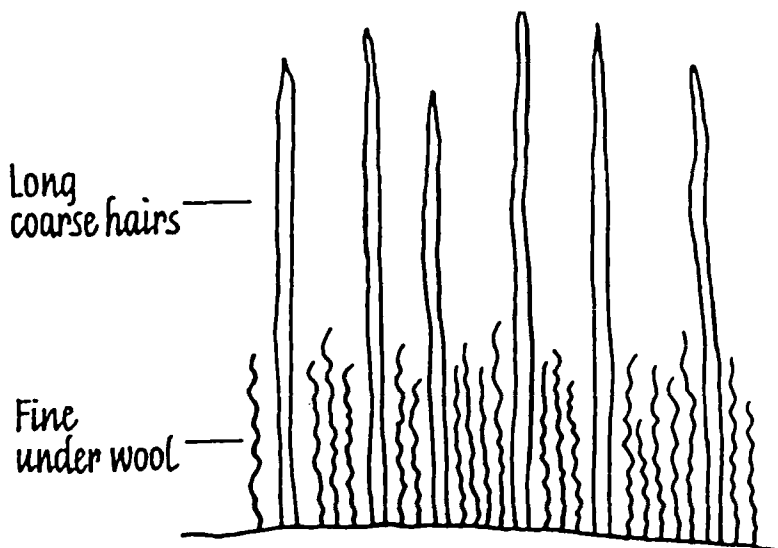
Sample	Wool range	Mean $\pm$ S.D	Mode	Hair range	Mean $\pm$ S.D.
Yak					
wild (NHM) (1)	36–96,124	64.2 $\pm$ 16.5	60	fine lacking	
domestic (NHM) (2a)	18, 44–112	76.3 $\pm$ 18.6	79	fine lacking	
(2b)	10–30	19.4 $\pm$ 3.0	19	34–80	50.6 $\pm$ 14.9
(3)	16–84	32.0 $\pm$ 15.6	20	continuous distribution	
commercial samples					
(BTTG)	10–54	25.9 $\pm$ 10.3	20	continuous distribution	
(Nina)	15–34	24.2 $\pm$ 5.3	26	36–118	62.0 $\pm$ 24.1
Serow					
NHM 24.5.29.1 belly	18–34	25.5 $\pm$ 3.9	26	38–110	56.6 $\pm$ 21.8
Goral					
NHM 45.1.8.325	8–28	12.5 $\pm$ 4.4	12	40–62	51.2 $\pm$ 9.2
Tahr					
NHM 96.11.21.1 ? belly	8–34	15.2 $\pm$ 4.1	15	36–96	61.5 $\pm$ 15.6
NHM 96.11.21.1 back	12–28	15.4 $\pm$ 3.5	14	34–78	54.8 $\pm$ 14.9
NHM no no. shoulder	10–26	18.0 $\pm$ 2.7	18	28–88	48.3 $\pm$ 19.0
"Yeti"	12–28	16.9 $\pm$ 2.7	16	70–180	140.9 $\pm$ 36.6
Ibex					
NHM 41.596	10–24	15.8 $\pm$ 3.3	15	34–140	71.4 $\pm$ 28.3
NHM 75.10.9.2	8–26	15.2 $\pm$ 3.5	14	39–106	65 $\pm$ 16.8

NHM = Natural History Museum

Hairs outside the main range are listed separately

scale pattern more like that of sheep than goats.

The hair diameter measurements are shown in Table 1 with other hair measurements for comparison. In the “yeti” sample, 20% of the underwool fibres had slight natural pigmentation, while 96% of the outer hairs were densely pigmented. The pigment in the underwool was concentrated towards one side of the fibres, which is a feature of ruminants, and was noted in the Khumjung scalp by Burns (1962). She also noted diffuse pigmentation, which I had earlier noted in the tahr.



(from the book *HAIR* by M.L. Ryder, published by Edward Arnold in 1973)

Fig. 1. Coat structure of the goat-antelopes (from Ryder, 1973)

Elimination sequence and descriptions of comparative material

If one goes through the different families of the Ruminants (in the area) as follows: this “yeti” skin is not from deer (Cervidae) because deer have a shorter, bristly outer coat (Ryder & Kay, 1973). Within the Bovidae it is not cattle (Bovinae) because these do not have a double coat, nor is it yak because of the different coat structure evident by eye (Table 1). To the eye, the coat structure of the wild yak appeared more like that of a hairy domestic sheep or a goat than that of an ox, with wavy heterotype hairs up to 23cm long and a dense underwool of medium, as well as fine fibres. What appeared to be different coat types, like the different fleece types of domestic sheep (Ryder, 1987), were shown by the hair measurements (Table 1) to be due to seasonal variation like that seen in goats (Ryder, 1970). Samples 2b and Nina have the typical bimodal winter distribution of coarse, outer hairs and fine underwool. The wild and 2a samples had mainly outer hair, the lack of underwool perhaps indicating the late summer coat before the underwool has grown. Samples 3 and BTTG, with a continuous fibre diameter distribution, represent the early summer coat in which the hairs have not yet become as coarse as in winter. The yak hairs were distinctly bovine under the microscope — straight with pigment in the cortex but not in the cuticle — giving the hair a characteristic, pale “rind”. The medulla was non-latticed.

Of the remaining Sub-family, the Caprinae, it is not Tribe Saiga because these have a sandy colour. Considering Tribe Rupicaprini in detail: Serow (*Capricornis sumatrensis*), although an animal of the sub-tropics (Schaller, 1977), its description suggests this skin and the serow were implicated in the Khumjung scalp. The serow is dark and self-coloured with long, coarse hair and a long (40cm) white or brown mane (Macdonald, 1984).

Goral. Schaller (1977) placed this animal south of the Himalayas, but according to Macdonald (1984) it ranges from north India to south east Siberia. Although it has long body hair and a short mane, its variable colour does not correspond with this “yeti” skin.

Tribe Ovibovini: Takin (*Budorcas taxicolor*), can be excluded because of its tan colour.

Tribe Caprini (sheep and goats): Tahr. This is a Himalayan animal which Schaller (1977) shows as being restricted to Nepal. It had a thick skin, copper to black, self-colour hair and a long white ruff (Macdonald 1984). The hair diameter range corresponds to that of this skin (Table 1). The Khumjung scalp could well have been made from tahr skin rather than serow.

Blue sheep (*Pseudovis nayaur*). This Himalayan animal can be excluded because of its (grey) colour.

Ibex. Although distributed more to the west and north of Tibet (Schaller, 1977), this wild goat has a similar colour and coat structure to this “yeti” skin, but the hair is much shorter.

Argali (*Ovis ammon*). This Tibetan wild sheep can be excluded because of its light brown colour and coat structure.

The process of elimination and detailed examination narrowed the possibilities to the Rupicaprids: mainland serow and goral; and the Caprinid tahr. An examination of skins of these showed that the latter had most in common with the “yeti” skin. The hair of five tahr skins was particularly long (15cm), the 2cm underwool was noticeably dense and the skin exceptionally thick (2-3mm). The hair was dark brown with a white base, with a change to white on the shoulder, the key here being a change of hair slope to form a whorl, which created the ruff, and which was not seen in the serow and goral. Despite the apparent lack of agouti banding on the hairs, all the tahr reference skins had a white belly.

Discussion

Descriptions of previous “yeti” skins have placed too much reliance on individual hairs (McNeely *et al.* 1973; Shackley, 1983). This ignores the existence of more than one type of hair in the coat, and the need to define its structure by hair measurement. Despite this it is difficult to distinguish closely related species. They “clutch at straws” by emphasising a casual reference to monkey-like features and the Khumjung scalp mites being different from serow mites (Hill, 1961). Shortly after the paper of Hill (1961) appeared it was known that the mites were “a common pest of stored products” (Burns, 1990). Since this investigation began as a study of a “yeti” skin, this note should end by saying that despite the review of “yeti” sightings by Shackley (1983),

skin or hair remains are still lacking.

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